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ABSTRACT

A study was conducted at the College of Alameda to assess the factors contributing to math anxiety and to determine methods of fostering positive attitudes toward math among women and non-traditional students. During the study, 150 students in three introductory algebra sections were administered a series of attitude scales designed to measure their level of math anxiety and to assess personal feelings toward success in math, the role of the teacher in student success, the sex appropriateness of math, and the usefulness of math in later life. Those test results reflecting high anxiety and/or poor, negative, or conflicting attitudes were selected as the basis for class discussions, during which students were challenged to find answers to the math anxiety problem. Major test and discussion findings indicate that: (1) though most students wanted to do well in math, many women students indicated that they would rather their peers not know if they were successful in math; (2) while the majority of students did not see math as a male domain, more men than women felt they would have an occasion to use math both on and off the job; (3) most instructors were regarded as somewhat aloof, with negative attitudes being more pronounced among the women; and (4) math anxiety seemed to be induced more by testing than by math itself. The report includes a literature review, 20 recommendations for the amelioration of math anxiety, and the attitude scales. (JP)

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A METHOD FOR DEALING WITH ATTITUDES AND ANXIETIES IN MATHEMATICS

by

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ABSTRACT

Math anxiety and negative attitudes about math affect large numbers of people, particularly women and nontraditional students. With increasing numbers of women and nontraditional students with poor math backgrounds enrolling at the College of Alameda, an attempt was made to combat the problem of math anxiety through instructor and student participation in creating a method for dealing with anxiety and attitudes in mathematics.

To establish a basis for the method, a series of five attitude scales related to math learning were administered to three classes in elementary algebra (N = approximately 150) at the College of Alameda. These scales, developed jointly by Elizabeth Fennema and Julia Sherman (1976), contain twelve items each, with six items reflecting positive content and six items reflecting negative content. A Likert-type scoring scheme was used to differentiate between strongly agree (score 5) to strongly disagree (score 1).

Respondents were identified by sex only. Average scores for both women and men were computed for each item. Twenty-four items with scores reflecting poor, negative, or conflicting attitudes or high anxiety were singled out to form a basis for class discussion. Students were encouraged to suggest methods which, from their perspective, would assist in attitude modification and/or relieving

high anxiety. Discussions involved psychological concepts of learning, such as ego-reinforcement, motivation, positive attitude, and anxiety and its effect on learning. The result was a twenty-item method for dealing with the problems of attitudes and anxieties. Each item in the method is a consensus of the class opinion.

It is recommended that the method be implemented as soon as possible in elementary algebra classes at College of Alameda where both the instructor and students agree with the majority of its content. It is further recommended that a study be done to ascertain if, in fact, using such a method does change attitudes and/or lower anxieties concerning mathematics.

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INTRODUCTION

The Peralta Community College District comprises five colleges that serve the students residing in northern Alameda County, California. College of Alameda is one of the Peralta colleges. It is comprehensive in its offerings and strives to serve the various needs of an urban student body of approximately 7,500 students. College of Alameda subscribes to the traditional "open door" philosophy of California community colleges. This open door admissions policy, coupled with its urban location, had resulted in a high enrollment of "new students" (Cross,1971:xiii) as well as older students in need of extensive remediation in basic skills.

Recognizing and assessing the needs of these students, the college has made a serious commitment to the development of remedial education and special assistance programs to assist many of these students in achieving their educational goals. In 1977 the college created the Learning Assistance in Basic Skills (LABS) center to assist in supplying tutorial assistance, assessment testing in basic skills, as well as other services to both students and faculty.

Although the LABS center is meeting the needs of many of these students, and the college does offer an extensive array of courses from remedial arithmetic through

algebra and geometry, little has been done to assess and deal with student attitudes and anxieties as they relate to the learning of mathematics.

Math anxiety, more formally known as mathophobia--a term coined by Mitchell Lazarus--is defined as "an irrational and impeditive dread of mathematics" (1974:16). Mathophobia is not some rare malady that only affects a few persons. According to Lazarus, "By the time a student leaves school, the chances are good that he will have acquired mathophobia at one point or another during his education" (1974:16). Like the common cold, mathophobia knows no boundaries of sex, race, age, or other physical parameters. In her book Overcoming Math Anxiety, Sheila Tobias points out that "math anxiety is a condition that disproportionately affects females and racial minorities of both sexes" (1978:78). Lazarus comments on this by saying, "There are no hard data on this question, nor is there a firm list of criteria to judge who is mathophobic and who is not . . . . The children and adults who should be judged mathophobic probably constitute a clear majority: It is likely that mathophobics outnumber by far those who are comforable with mathematics" (1974:17).

Lack of adequate mathematical background coupled with a poor attitude and math anxiety may very well inhibit, if not actually terminate, the academic progress of many otherwise capable students. In 1977 Raplh Norman completed a study which showed that there was "consistent decline in

favorable attitudes toward mathematics by both sexes from grade two through college, with significantly poorer attitudes from females from grade nine on" (Norman,1977:256).

The fact that so many people experience math anxiety--many at the arithmetic level and others at progressively higher levels of math through the calculus--and the fact that mathematics is essential for daily living makes the study of ways of dealing with this problem one of utmost importance.

Since College of Alameda has a high percentage of women (53 percent) and minorities (64 percent), and since it was probable that these groups suffer from poor attitude and math anxiety which may seriously affect their lives, the purpose of this practicum was to develop a method for dealing with these attitudes and anxieties.

In order to establish the existence of certain attitudes and anxieties regarding mathematics, a series of four attitude scales and one math anxiety scale (Appendixes A, B, C, D, and E) were administered to approximately 150 students enrolled in three classes in elementary algebra. Likert-type scoring system was used to establish favorable to unfavorable attitudes and to form a basis for class discussion regarding reasons for them.

Items on the scales revealing poor or negative attiutde or math anxiety were discussed at length with each class to determine what remedies the students felt would be

most beneficial in removing these barriers to success in learning mathematics. Allowance was made for personal conference with the researcher to discuss attitudes and anxieties.

Following the class discussions, personal conferences, and a review of the written recommendations, a summary of way of dealing with the problem was again discussed with the classes. The feasibility of implement- some of the recommendations was discussed with the director of LABS, and, where possible, implementation was assured.

Recommendations for dealing with poor attitude and math anxiety formed the basis for the "Method for Dealing with Attitudes and Anxieties in Mathematics" (Table VII).

BACKGROUND AND SIGNIFICANCE

"Anxiety is a fear of some uncertain event" (Zeno:356-264 B. C. See Yonge translation). Anxiety, or fear of the unknown is not some recent term or concept put forth by psychologists, as evidenced by the quotation from Zeno. However, anxiety and a systematic study of it probably did not begin seriously until modern psychology made its appearance with Freud (1856-1939) at the beginning of this century.

> Freud's views about anxiety evolved along with other aspects of his theory. At first he though that attacks of anxiety in his patients gave evidence of repressed instinctive (libidinal)excitation . . . .

> Later, as he developed the theory of id, ego, and superego, he assigned anxiety production to the ego" (Hilgard,1975:351).

There is little doubt of the impact that the theories of Freud and other leading psychologists such as Thorndike, Pavlov, Guthrie, Hull, Tolman, and Skinner have had on educational psychology and education as it is practiced today. However, anxiety in general, and anxiety in learning in particular, still remain with us today in spite of theories and attempts to deal with these anxieties. "American psychologists, notably Spence (1958) have become much concerned with the concept of anxiety and its relationship to learning . . . " (Bugelski,1971:50).

The term "anxiety" may mean different things to different people. Thus, it is necessary to establish a more formal and concrete definition of the term than that stated by Zeno. According to Charles E. Skinner, one must distinguish between the concepts of <u>fear</u> and <u>anxiety</u>.

> To understand the apprehensions to which children and adults are subject it is useful to distinguish <u>fear</u> from <u>anxiety</u>. The apprehension of danger or disaster in <u>anxiety</u> arises from something within the person himself, from his own conflicting drives and impulses, and unresolved problems. Thus <u>anxiety</u> is a response to a hidden and subjective danger. <u>Fear</u> is a response to an obvious and objective danger. Also, according to this concept, the subjective factor that leads to anxiety may be unconscious or unrecognized (1959:265).

Anxiety, to some degree, exists in any learning situation. Fear of embarrassment, fear of failure, fear of

social pressure, as well as unconscious fears all contribute to anxiety in learning. The extent to which anxiety levels inhibit (or enhance) learning is still a subject of some debate.

> Although there is some dispute about the facts, the common thinking on this relationship (anxiety vs. learning) seems to be that people of high anxiety do well on simple tasks but do poorly on more complex problems" (Bugelski, 1971:50).

However, there are somewhat opposing views on this issue.

> It is known that high levels of anxiety can result in tunnel vision on the part of the student and can seriously impede cognitive processes. It is further true that ambiguity tends to increase anxiety for many people . . ." (Losak, 1974:30).

> Although it was once fashionable to speak of anxiety as unequivocally undersirable in an educational setting, present thinking and research do not support this generalization. Excessive anxiety may indeed hinder learning (Gage,1963:496).

The extent to which anxiety affects the learning process is also related to the ability of the learner. As Losak points out: "There is, however, an interaction with ability level which indicates that this principle applies primarily to students of medium range scholastic ability" (1974:30).

In view of the fact that many of the students attending community colleges today are of the medium to low range in scholastic ability, the problem of anxiety and its impingement on learning is of major interest. The

problem is complicated by the sheer diversity of the student population.

> The teacher in the community college is faced with the challenge of facilitating learning for a population which is extremely heterogeneous with respect to age, interests, motivation, academic preparedness and socio-economic status" (Losak,1974:32).

The challenge is further complicated by the increased number of women and minorities who are enrolling in the community colleges. It is no secret that women have good reason for math anxiety and poor attitude. Elizabeth Fennema and Julia Sherman concluded from a study that, "The stereotyping of mathematics as a male domain has a subtle but powerful effect on women, especially as it affects decisions to continue or terminate the study of mathematics" (1977:372).

Further, with regard to math anxiety and possible success in a chosen occupation, Mathison stated: "Math anxiety is recognized as a significant problem because of the growing awareness of the importance of mathematics. Not only is math vital to daily transactions, it is a skill required for most occupations . . ." (1977:3). Further on in her paper she stated, "Math anxiety typically results in avoidance of math and math classes, severely limiting an individual's educational and occupational choices" (3).

The extent to which math avoidance affects career choices was clearly demonstrated by Sells in 1975. Sells studied the mathematical preparation of freshmen entering the University of California at Berkeley and found that only

8 percent of the women (as compared to 57 percent of the men) had an adequate high school background for any of the calculus sequences. Thus 92 percent of the entering women were effectively eliminated from participating in careers in mathematical, physical and biological sciences, most social sciences and engineering--all of which at the Berkeley campus require calculus (Sells, 1975).

The exact reasons for so many persons being afflicted with math anxiety and having poor attitudes may never be established to everyone's satisfaction. However, three researchers (Skinner, Zacharias, and Gagne) shed some light on the problem:

> Attitudes have been defined as ideas with emotional content, important beliefs, prejudices, biases, predispositions, appreciations, and as a state of readiness or set (Skinner,1959:326).

> One of the major sources of mathophobia is the great gap between the universally valid arithmetic of abstract numbers and the arithmetic that people use for describing concrete quantities (Zacharias,1976:21).

> Mathematics is a subject that lends itself well to the illustration of learning hierarchies of intellectual skills. The reason is quite simply, that mathematics is preponderantly composed of intellectual skills, and not very much verbal information (Gagne,970:246).

The extent to which the instructor and instructional materials may contribute, either positively or negatively, to the notions of Skinner, Zacharias, and Gagne is of particular importance in possibly eliminating some of the math anxiety and poor attitudes experienced by students.

In this respect there are encouraging, if not somewhat conflicting, results. In a study concerned with attitudes, Aiken (1976:293-311) found that the instructor was significantly more influential in development of attitudes towards mathematics than curriculum. In support of Aiken's position are researchers Cooper and Petrosky (1976:226-233). In their study the identified the faculty characteristics which have the most positive effect on student attitude. These include respect for students built on understanding and kindness, clarity of explanation, attention to the learning problem of individual students, and clear but flexible goals and directions for the course. However, there is reason to believe that the instructional mode may also have a positive effect on the student:

> There is a reason to suppose that an instructional mode which requires self-instruction may be very efficient, when properly designed, and may help to establish valuable habits of independent study on the part of the student (Gagne,1970:29).

On the negative side, Suydam and Weaver (1975) maintain that there is no solid body of evidence to document the popular assertion that there is a significant positive connection between pupil attitudes toward mathematics and achievement in the subject.

Evidently one must seek sources for changing attitudes and reducing anxieties other than curriculum modification. It has already been observed that Freud assigned anxiety production to the ego. It has been some

fifty years since that conjecture, and its relevance to education is still being pursued:

> Ego strength has also come to be viewed as a significant variable in scholastic achievement. David McClelland suggests in a recent article in the American Psychologist (1973) that educational attempts to facilitate ego development may be beneficial to student learning (Losak,1974:31).

Thus, it may be that attitudes and anxieties can be changed for the better by permitting the students to actively participate in class discussions regarding these notions. The classroom is an ideal forum for these discussions. Support for this approach comes from the following sources:

> Some attention needs to be devoted to replacing the negative attitude with a positive one as well as communicating mathematical knowledge: in particular, the teachers and the students need to feel that the students can handle mathematics (Gray,1977:375).

> Evidence relating to curriculum as a means of changing student attitudes is discouraging. Lagey (1956) concluded that there were not noticeable direct relationships between content of courses in the curriculum and attitude modification . . . . A classroom discussion of causes is more likely to be of value to pupils in developing attitudes (Skinner,1959:334).

Each quarter approximately 1,400 students enroll at College of Alameda in mathematics courses ranging from arithmetic review through the calculus. Enrollment data supplied by the Science, Physical and Allied Health (SPAHE) Divsion--the division responsible for offering all mathematics courses--indicate that over 90 percent of the students

enroll in courses that are usually classified as remedial, developmental, or of high school equivalency. Many of the students enrolled in these courses are taking them for the first time: for review, to make up course deficiencies, or to meet course prerequisites. For many of the older students, as well as many of the women and nontraditional students, participation in these courses may elicit high anxiety and negative attitude. Failure to achieve in course work at this level may aggravate the problem of math anxiety and poor attitude even further. There are in addition to the aggravation problem, implications regarding withdrawal from the courses as well as possible withdrawals from the college. Therefore, if a method can be devised to deal with the problems of high anxiety and attitudes toward mathematics, then both the students and the college may benefit through improved retention and increased achievement.

PROCEDURES

In 1976 Elizabeth Fennema and Julia Sherman developed a set of nine, domain specific, Likert-type scales which were intended to measure attitudes related to mathematics. Each of the nine scales was designed to assess an attitude that was hypothesized to be related to the learning and study of mathematics by both males and females. The nine attitude scales include: (a) confidence

in learning, (b) father, mother, and teacher scales measuring perceptions of attitudes toward one as a learner of mathematics (three separate scales), (c) effectance motivation in mathematics, (d) attitude toward success in mathematics, (e) mathematics as a male domain, (f) usefulness of mathematics, and (g) a mathematics anxiety scale.

Of the nine scales, five were selected as being particularly relevant to this practicum. The scales chosen were most applicable to the development of the method and ones which did not involve an inordinate amount of time for student response or researcher time in assessing the results. The scales selected were:

1. Attitude Toward Success in Mathematics Scale (Appendix A)
2. Attitude Toward Teacher Scale (Appendix B)
3. Mathematics as a Male Domain (Appendix C)
4. Usefulness of Mathematics Scale (Appendix D)
5. Mathematics Anxiety Scale (Appendix E)

Three classes in beginning algebra at the College of Alameda were chosen for the study. These classes, which were comprised of approximately 150 students, were chosen because they were composed of students who were experiencing algebra for the first time. In the opinion of the researcher, these classes were composed, in a large part, of typical high-risk students, and thus would have anxieties and attitudes which might affect their success in mathematics.

Early in the 1980 winter quarter the attitude/anxiety scales were administered to the three classes over a period of five days. The purpose of each scale was discussed with each class, and the scoring was carefully explained. Students were allowed as much time as needed and were requested to be as honest as possible. Respondents were identifed by sex only. Students were asked not to sign the scale. An average score for each of the twelve items on each scale for males and females were computed. Item scores were examined for extreme values (5 = strongly agree to 1 = strongly disagree). Items from each of the scales reflecting negative or conflicting attitudes or anxieties were summarized for class discussion (See Table VI). The summary of items was then discussed with each of the classes as to probable reasons for the extremes, and suggestions for attitude and anxiety reduction/modification were formulated. The finalized set of recommendations for dealing with negative attitudes and high math anxiety were then summarized into "A Method for Dealing with Attitudes and Anxiety in Mathematics" (Table VII).

For purposes of this study, it was assumed that the three classes chosen were typical of the students studying beginning algebra at College of Alameda. It was further assumed that the responses to the scales were not influenced by instructor presence or peer pressure, and, in fact, reflected the true attitudes of the students.

Limitations are: (1) The wording and/or content of an item may not have been clearly understood by the student. (2) Content of an item may not have been specific enough to elicit the best response. (3) Organization of the scales--six positive items followed by six negative items rather than random sequencing--may have biased the results.

RESULTS

Each of the five scales used contained twelve items. The first six items were positive in content and the last six items were negative in content. From the scoring system used, any score above three would indicate some degree of agreement, and any score below three would indicate some degree of disagreement. It would, therefore, be expected that the first six items on the scales would have scores above three, and the last six items would have scores below three, assuming the respondent did not have unfavorable attitudes or math anxiety. This assumption was used as a basis for establishing items with scores reflecting attitudes that were poor, negative, or conflicting. A score below three on items one through six, or a score above three on items seven through twelve were, in most cases, considered significant and worthy of more discussion.

Table I shows the average score for each item for both women and men on the Attitude Toward Success in

Mathematics Scale. Particular items deemed worthy of further class discussion have been repeated below the table. Choice of the items was the responsibility of the researcher.

Table I

Attitude Toward Success in Mathematics Scale

Item Number	Women	Men
1	4.37	4.69
2	4.46	4.62
3	4.80	4.86
4	4.00	4.10
5	4.05	4.21
6	4.17	4.55
7	2.00	2.62
8	2.95	2.10
9	3.61	2.10
10	3.48	1.96
11	3.46	1.41
12	3.78	2.83

Items worthy of further discussion:

No. 3 "I'd be happy to get top grades in math." Women (4.80) Men (4.86)

No. 9 "If I got good grades in math, I would try to hide it." Women (3.61) Men (2.10)

No. 10 "If I got the highest grade in math, I'd prefer no one knew about it." Women (3.48) Men (1.96)

No. 11 "It would make people like me less if I were a really good math student." Women (3.46) Men (1.41)

No. 12 "I don't like people to think I'm smart in math." Women (3.78) (Men (2.83)

For the women, there is an obvious conflict of attitudes toward earning top grades and having others know that they

earned top grades. (See Items Nos. 3, 9, and 10.)

Table II shows the average score for each item for both women and men on the Attitude Toward Teachers Scale. Statements reflecting attitudes which might be considered negative, poor, or conflicting have been repeated for clarity. These items formed the basis for class discussion. Choice and determination of these items was the responsibility of the researcher.

Table II

Attitudes Towards Teachers Scale

Item Number	Women	Men
1	3.21	3.64
2	3.39	3.14
3	3.36	3.36
4	3.18	3.29
5	2.82	3.00
6	2.25	2.14
7	2.36	2.36
8	2.07	2.14
9	1.86	1.93
10	2.00	2.08
11	3.18	1.93
12	3.07	1.86

Items worthy of further discussion:

No. 5 "My math teachers have been interested in my progress in math." Women (2.82) Men (3.00)

No. 6 "I would talk to my math teachers about a career in math." Women (2.25) Men (2.14)

No. 11 "My math teachers would think I wasn't serious if it told them I was interested in a career in science and math." Women (3.18) Men (1.93)

No. 12 "I have a hard time getting teachers to talk seriously with me about math." Women (3.07) Men (1.86)

Negative attitudes appear to be more pronounced for the Women than they do for the men, particularly with regard to Items 11 and 12.

Table III shows the average score for each item for both women and men on the Mathematics as a Male Domain Scale. From this table items for which women and men average scores differed by 0.50 or more were chosen for further discussion. Choice of the measure of difference was the responsibility of the researcher.

Table III

Mathematics as a Male Domain Scale

Item Number	Women	Men
1	4.27	4.15
2	4.67	4.77
3	4.80	4.04
4	4.83	4.15
5	4.10	4.49
6	4.77	3.92
7	1.50	2.78
8	1.63	2.45
9	1.47	2.92
10	1.57	1.54
11	1.20	1.38
12	1.43	1.15

Items worthy of further discussion:

No. 3 "I would trust a woman just as much as I would trust a man to figure out important calculations." Women (4.80) Men (4.04) Difference (.76)

No. 4 "Girls can do just as well in math as boys." Women (4.83) Men (4.15) Difference (.68)

No. 5 "Males are not naturally better than females in math." Women (4.10) Men (3.49) Difference (1.71)

No. 6 "Women certainly are logical enough to do well in math." Women (4.77) Men (3.92) Difference (.85)

No. 7 "It's hard to believe a female could be a genius in math." Women (1.50) Men (2.78) Difference (1.28)

No. 8 "When a woman has to solve a math problem, it is feminine to ask a man for help." Women (1.62) Men (2.45) Difference (.82)

No. 9 "I would have more faith in the answer for a math problem solved by a man than by a woman." Women (1.47) Men (2.92) Difference (1.45)

Results indicate differences in attitudes regarding sex role in mathematics. In almost all cases, women agree more strongly on items 7 through 12 than do the men.

Table IV shows the average score for each item for both men and women on the Usefulness of Mathematics Scale. From the table, scores on statements reflecting attitudes which might be considered negative, poor, or conflicting have been repeated for clarity. Determination of these items was the responsibility of the researcher. The chosen items formed the basis for class discussion.

Table IV

Usefulness of Mathematics Scale

Item Number	Women	Men
1	4.33	4.76
2	4.17	4.45
3	4.10	4.48
4	4.36	4.45
5	4.00	3.72
6	3.31	4.38
7	2.57	1.62
8	1.71	1.82
9	3.64	1.83
10	1.50	1.59
11	1.29	1.86
12	1.64	1.86

Items worthy of discussion:

No. 5 "I'll need a firm mastery of mathematics for my future work." Women (4.00) Men (3.72)

No. 6 "I will use mathematics in many ways as an adult." Women (2.31) Men (4.38)

No. 7 "Mathematics is of no relevance to my life." Women (2.57) Men (1.62)

No. 9 "I see mathematics as a subject I will rarely use in my daily life as an adult." Women (3.64) Men (1.62)

Results indicate that women see math as primarily job oriented (Women 4.00 Men 3.72), whereas men see it as useful through out life. Items 5, 6, and 9 reveal these conflicting attitudes.

Table V shows the average score for each item for both women and men on the Mathematics Anxiety Scale. From the table, scores on statements reflecting anxieties which

might be considered negative, poor, or conflicting have been repeated for clarity. Determination of these items was the responsibility of the researcher. Items chosen formed the basis for class discussion.

Table V

Mathematics Anxiety Scale

Item Number	Women	Men
1	3.66	3.45
2	3.75	3.35
3	3.21	3.35
4	2.05	2.80
5	1.31	2.33
6	3.42	3.65
7	2.63	2.45
8	2.43	2.40
9	2.84	2.58
10	3.52	2.48
11	4.04	3.84
12	2.50	2.25

Items worthy of further discussion:

No. 4 "I almost never have gotten shook up during a math test." Women (2.05) Men (2.80)

No. 5 "I usually have been at ease during a math test." Women (1.31) Men (2.33)

No. 10 "My mind goes blank, and I am unable to think clearly when working mathematics." Women (3.52) Men (2.48)

No. 11 "A math test would scare me." Women (4.04) Men (3.84)

Results show that high test anxiety is experienced by both men and women.

Analysis of the five scales resulted in twenty-four items selected for further class discussion (Table VI).

Table VI

Items Selected from Attitude and Anxiety Scales for Class Discussions

Number	Item
1	I'd be happy to get top grades in math.
2	If I got good grades in math, I would try to hide it.
3	If I got the highest grade in math, I'd prefer no one knew about it.
4	It would make people like me less if I were really a good math student.
5	I don't like people to think I'm smart in math.
6	My math teachers have been interested in my progress in math.
7	I would talk to my math teachers about a career in math.
8	My math teachers would think I wasn't serious if I told them I was interested in a career in science and math.
9	I have a hard time getting teachers to talk seriously with me about math.
10	I would trust a woman just as much as I would trust a man to figure out important calculations.
11	Girls can do just as well in math as boys.
12	Males are not naturally better than females in math.
13	Women certainly are logical enough to do well in math.
14	It's hard to believe a female could be a genius in math.

Table VI (continued)

Number	Item
15	When a woman has to solve a math problem, it is feminine to ask a man for help.
16	I would have more faith in the answer for a math problem solved by a man than by a woman.
17	I'll need a firm mastery of mathematics for my future work.
18	I will use mathematics in many ways as an adult.
19	Mathematics is of no relevance to my life.
20	I see mathematics as a subject I will rarely use in my daily life.
21	I almost never have gotten shook up during a math test.
22	I usually have been at ease during a math test.
23	My mind goes blank, and I am unable to think clearly when working mathematics.
24	A math test would scare me.

Private discussions with students as well as written comments did not alter the set of items chosen for class discussion.

Class discussion on these twenty-four items lasted over a period of three class days. Following the discussions, a list of class generated items formed the basis for "A Method for Dealing with Attitudes and Anxieties in Mathematics" (Table VII).

Table VII

A Method for Dealing with
Attitudes and Anxieties in Mathematics

Number	Method
1	Spend at least one class hour at the beginning of the term discussing reasons for math anxiety. In particular, discuss fear of embarrassment, fear of failure, fear of social pressure.
2	Clearly discuss grading practices, standards for success, and why they are important for the student. Have in written form also.
3	Clearly describe goals and objectivies of the class. These should also be in written form.
4	Provide for testing to take place over several days.
5	All tests, including final, to be taken in library (supervised) with no time limit.
6	Provide a sample test for students to study before taking achievement test.
7	Provide for mastery learning of material. Allow students to take additional test(s) to improve score. A maximum of four tests is recommended.
8	Provide for <u>immediate</u> grading of test.
9	Provide for immediate discussion of errors on tests.
10	Discuss career opportunities that would appeal equally to both men and women. Computer programming and data processing would serve as a starting point.
11	Provide a list of qualified tutors for each class. Have tutors meet with each class to get to know students and their problems.

Table VII (continued)

Number	Method
12	Set up, on a volunteer basis, a phone system so that students can get missed assignments from other students. Discuss problems as well as follow-up for missed tests and excessive absences.
13	Use a positive grading system. Praise students for what they get correct. Avoid the use of red penciling and marking down. Score examination questions and homework by points correct rather than points marked off.
14	Encourage students to permit instructor to post names of students with highest grade on tests. Also, post perfect test and homework papers.
15	Provide for an incentive system for course grade. If student receives all A's or B's on achievement tests, they need not take a final.
16	Encourage women to explore careers that require math. This can be done by looking at college catalogs, newspaper employment advertisement, and job descriptions.
17	Ask students to "drop by" to discuss their progress. This applies particularly to students who are doing poorly or who have missed a test.
18	Instructor should avoid statements like, "This problem is too easy." "I never had any trouble with math." "I can't understand why you don't understand this problem."
19	Let students know that you are not perfect, even though math may be easy for you. Discuss with them the fact that you have trouble with astronomy or poetry or certain sports or politics or any number of areas where they are "experts."
20	Allow for differences in learning abilities and learning rates. Be flexible--within limits--for completion of assignments and taking of achievement tests.

DISCUSSION, IMPLICATIONS, AND RECOMMENDATIONS

Scores on the five Fennema/Sherman scales are shown in Tables I - V. With regard to the Attitude Toward Success in Mathematics Scale (see Table I), there was an obvious conflict of attitude regarding good grades (Item 3) and trying to hide the results (Item 9). When this was discussed with the class, they generally felt that peer pressure would result in their being labeled someone who is a little "strange" since "doing well in math is not the normal thing to do" (student comment). The relatively high scores on the first six items for both women and men would appear to be related to ego reinforcement: a concept already identified as being closely related to anxiety. There is little doubt from the scores on this scale that students really want to do well in math. Their anxiety seems to stem to some degree from peer pressure.

Table II shows the results concerning Attitudes about Teachers. The clustering of the scores around the value of three for items 1 - 6 suggests a degree of indecisiveness on the part of both men and women. It appears that their attitudes about teachers of mathematics are very uncertain. When this was discussed with the classes, the consensus was that most math teachers appeared aloof and distant and did not come across as warm human beings. It would appear from the results of this table that most students do not have a very high regard for their math instructors as they do not seem to impress them one way

or the other. Changing attitudes would be the responsibility of the individual instructor. This is a particularly sensitive area, and in Skinner's practical suggestions for good teaching he makes note of it:

> Set a good example in one's attitude to the pupil and the task at hand, for, in the final analysis, the teacher's personality is the greatest single factor in success or failure of motivating school learning (1959:468)

Table III reflects the attitudes of women and men with regard to Mathematics as a Male Domain. The results shown here may stem from the emerging women's liberation movement as reflected by the rather extreme scores of men and women. Women's attitudes appear very strong on both positive and negative items. Most women in the classes wanted to know more about how math would help them succeed in various careers. These discussions resulted in the suggestions to examine college catalogs regarding requirements for various majors and job descriptions found in newspapers.

Table IV shows the attitudes that students had concerning the Usefullness of of Mathematics. Scores on Items 5, 6, 7, and 9 were discussed with the students to determine why there was such a disparity in scores between women and men. The consensus of opinion of the students was that women see math useful more on the job rather than in daily life. On the other hand, men felt that they would probably have occasion to use math both on and off

the job. Results of discussions with the students did not yield any recommendations for which there was a consensus of opinion. Most often voiced, however, were requests for more practical applications in daily life situations. Suggested examples ranged from, "How do I compute my gpa?" to "I'm building a guitar. Is there a mathematical formula for determining the location of the frets?"

A careful examination of Table V Mathematics Anxiety Scale, suggested that, in general, students in the three algebra classes were not anxious about mathematics per se; it was the testing that induced the anxiety. In discussions, students agree that test anxiety probably contributed to poor scores in many cases. Ways of relieving test anxiety as much as possible were incorporated into the Method. Items 4, 5, 6, 7, and 8 in the Method were agreed upon by the students as probable effective means for reducing test anxiety.

Through cooperative exploration and discussion, the students developed a method for dealing with attitudes and anxieties in mathematics. In so doing, the students produced an instrument that emboides many of the concepts and theories of some of the leaders in educational psychology. In particular, the method contains many of the suggestions put forth by Skinner:

> Adjust assignments and requirements to the child's abilities . . . . Bring the assignment within the child's experience and link it with the total environment . . . . Respect the personality of the child by appealing to ego-maximization . . . . Use praise and reproof judiciously . . . . Emphasize the positive approach . . . . Make assignments clear and concise . . . . Work out desirable goals and objectives . . . . Appeal to the total personality and as many motives as possible . . . (1959:467:469).

It is recommended that the Method be shared with all members of the mathematics staff at College of Alameda. It is also recommended that provision be made for implementing some of the nontraditional aspects of the Method, such as establishing a testing center in the library, allowing a period of several days (up to one week) to permit students to take examinations when they feel ready, and to remove the normal time constraints.

It is further recommended that a study involving an experimental-control group be done to ascertain if utilization of the Method has any impact on attitude modification and/or lowering math anxiety.

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APPENDIX A

Attitude Toward Success In Mathematics Scale

Male _____

Female _____

Directions: As you read each statement, you will know if you agree or disagree. If you strongly agree, put the number 5 in the blank opposite the statement. If you agree, but not strongly, that is, you have some reservations, then put the number 4 in the blank. If you disagree, but not strongly, then put number 2 in the blank. If you strongly disagree, then put the number 1 in the blank. If you neither agree nor disagree, that is you are not certain or you cannot answer, then put the number 3 in the blank. Please answer all parts.

THIS ATTITUDE SCALE IS BEING USED FOR RESEARCH PURPOSES ONLY. YOUR RESPONSES ARE CONFIDENTIAL. DO NOT SIGN THIS RESPONSE SHEET.

1. It would make me happy to be recognized as an excellent student in math. _____
2. I'd be proud to be the outstanding student in math. _____
3. I'd be happy to get top grades in math. _____
4. It would be really great to win a prize in mathematics. _____
5. Being first in a mathematics competition would make me pleased. _____
6. Being regarded as smart in math would be a great thing. _____
7. Winning a prize in math would make me feel unpleasantly conspicuous. _____
8. People would think I was some kind of a grind if I got A's in math. _____
9. If I got good grades in math I would try to hide it. _____
10. If I got the highest grade in math, I'd prefer no one knew about it. _____
11. It would make people like me less if I were a really good math student. _____
12. I don't like people to think I'm smart in math. _____

APPENDIX B

Attitudes Toward Teachers Scale

Male _____

Female _____

Directions: As you read each statement, you will know whether you agree or disagree. If you strongly agree, put the number 5 in the blank opposite the statement. If you agree, but not strongly, that is, with reservations, put the number 4 in the blank. If you disagree, but not strongly, put the number 2 in the blank. If you strongly disagree, put the number 1 in the blank. If you neither agree nor disagree, that is, you are not certain or you cannot answer, then put the number 3 in the blank. Please answer all parts.

THIS ATTITUDE SCALE IS BEING USED FOR RESEARCH PURPOSES ONLY. YOUR RESPONSES ARE CONFIDENTAL. DO NOT SIGN THIS RESPONSE SHEET.

1. My teachers have encouraged me to study more mathematics. _____
2. My teachers think I'm the kind of person who could do well in math. _____
3. Math teachers have made me feel I have the ability to go on in math. _____
4. My math teachers would encourage me to take all the math I can. _____
5. My math teachers have been interested in my progress in math. _____
6. I would talk to my math teachers about a caree in math. _____
7. When it comes to anything serious, I have felt ignored when talking to math teachers. _____
8. I have found it hard to win the respect of math teachers. _____
9. My teachers think advanced math is a waste of time for me. _____
10. Getting a math teacher to take me seriously has usually been a problem. _____
11. My teachers would think I wasn't serious if I told them I was interested in a career in science and math. _____
12. I have a hard time getting teachers to talk seriously with me about math. _____

APPENDIX C

Mathematics as a Male Domain Scale

Male _____

Female _____

Directions: As you read each statement, you will know whether you agree or disagree. If you strongly agree, put the number 5 in the blank opposite the statement. If you agree, but not strongly, that is with reservations, put the number 4 in the blank. If you disagree, but not strongly, put the number 2 in the blank. If you strongly disagree, put the number 1 in the blank. If you neither agree nor disagree, that is, you are not certain or you cannot answer, put the number 3 in the blank. Please answer all parts.

THIS ATTITUDE SCALE IS BEING USED FOR RESEARCH PURPOSES ONLY. YOU RESPONSES ARE CONFIDENTIAL. DO NOT SIGN THIS RESPONSE SHEET.

1. Females are as good as males in geometry. _____
2. Studying math is just as appropriate for men as for women. _____
3. I would trust a woman just as much as I would trust a man to figure out important calculations. _____
4. Girls can do just as well in math as boys can. _____
5. Males are not naturally better than females in math. _____
6. Women certainly are logical enough to do well in math. _____
7. It's hard to believe a female could be a genius in math. _____
8. When a woman has to solve a math problem, it is feminine to ask a man for help. _____
9. I would have more faith in the answer for a math problem solved by a man than a woman. _____
10. Girls who enjoy studying math are a bit peculiar. _____
11. Mathematics is for men; arithmetic is for women. _____
12. I would expect a woman mathematician to be a masculine type of person. _____

APPENDIX D

Usefulness of Mathematics Scale

Male _____

Female _____

Directions: As you read each statement, you will know whether you agree or disagree. If you strongly agree, put the number 5 in the blank opposite the statement. If you agree, but with reservations, then put the number 4 in the blank. If you disagree, but not stongly, put a 2 in the blank. If you strongly disagree, then put a 1 in the blank. If you neither agree nor disagree, that is, you are not certain or cannot answer, then put the number 3 in the blank. Please respond to all statements.

THIS ATTITUDE SCALE IS BEING USED FOR RESEARCH PURPOSES ONLY. YOUR RESPONSES ARE CONFIDENTIAL. DO NOT SIGN THIS RESPONSE SHEET.

1. I'll need mathematics for my future work. _____
2. I study mathematics because I know how useful it is. _____
3. Knowing mathematics will help me earn a living. _____
4. Mathematics is a worthwhile and necessary subject. _____
5. I'll need a firm mastery of mathematics for my future work. _____
6. I will use mathematics in many ways as an adult. _____
7. Mathematics is of no relevance to my life. _____
8. Mathematics will not be important to me in my life's work. _____
9. I see mathematics as a subject I will rarely use in my daily life as an adult. _____
10. Taking mathematics is a waste of my time. _____
11. In terms of my adult life, it is not important for me to do well in math at the community college. _____
12. I expect to have little use for math when I get out of school. _____

APPENDIX E

Mathematics Anxiety Scale

Male _____

Female _____

Directions: As you read each statement, you will know if you agree or disagree. If you strongly agree, then put the number 5 in the blank opposite the statement. If you agree, but not strongly, that is, you have some reservations, then put the number 4 in the blank. If you disagree, but not strongly, put the number 2 in the blank. If you strongly disagree, put the number 1 in the blank. If you neither agree nor disagree, that is, you are not certain or you cannot answer, then put the number 3 in the blank. Please respond to all statements.

THIS ATTITUDE SCALE IS BEING USED FOR RESEARCH PURPOSES ONLY. YOUR RESPONSES ARE CONFIDENTIAL. DO NOT SIGN THIS RESPONSE SHEET.

1. Math doesn't scare me at all. _____
2. It wouldn't bother me at all to take more math courses. _____
3. I haven't usually worried about being able to solve math problems. _____
4. I almost never have gotten shook up during a math test. _____
5. I usually have been at ease during a math test. _____
6. I usually have been at ease in math classes. _____
7. Mathematics usually makes me feel uncomfortable and nervous. _____
8. Mathematics makes me feel uncomfortable, restless, irritable and impatient. _____
9. I get a sinking feeling when I think of trying hard math problems. _____
10. My mind goes blank and I am unable to think clearly when working mathematics. _____
11. A math test would scare me. _____
12. Math makes me feel uneasy and confused. _____

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